EOS Validation Progress Report

Study: EOS Validation of Aerosol and Water Vapor Profiles by Raman Lidar
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Instrument Status:

- During the Water Vapor and Aerosol IOPs at the SGP site in September-October 1997, the CART Raman Lidar acquired about two weeks of data after the laser was successfully repaired. The GSFC Scanning Raman Lidar acquired about three weeks of data during this same experiment.
- Following the 1997 Water Vapor and Aerosol IOPs at the SGP CF site, the CART Raman lidar was down for about two months pending acquisition and installation of new Multi-Channel Scalar data acquisition cards. System resumed operations in late January 1998 and continued until hard disk crash in March 1998. After computer repairs and upgrades were performed in March, CART Raman Lidar resumed operations in late March and has operated over 60% of the time, with no major problems (see Figure 1).
- GSFC Scanning Raman Lidar has been undergoing upgrades to both hardware and software
  - Will acquire data at GSFC in June 1998 in coordination with sun photometer and MPL (Micropulse Lidar) to characterize urban summer aerosols and help MPL analysis efforts
  - Deployment to Andros Island in July 1998 for the CAMEX-3 experiment in August-September 1998 for water vapor and aerosol measurements

Data Processing Status:

- CART water vapor mixing ratio profile
  - profile algorithms and software developed and implemented as part of DOE ARM SGP RLPROF (Raman Lidar PROFile) Value-Added Procedure (VAP)
  - "best estimate" product in RLAER (Raman Lidar AERosol) VAP estimated 8/1/98
- CART relative humidity profile
  - algorithms and software that use radiosonde temperatures developed and tested; estimated implementation date into RLAER VAP 8/1/98
  - algorithm that uses temperatures derived from AERI and GOES radiances under development; estimated development date 7/1/98; implementation date 8/1/98
- CART precipitable water vapor algorithm and software developed, tested, and implemented
- CART aerosol scattering ratio profile
  - algorithm and software developed in RLPROF
  - successfully tested for WVIOP97 (Sept. 97) data; currently testing 1998 data
  - "best estimate" product in RLAER (est. implementation 8/1/98)
- CART aerosol backscattering and extinction profiles
  - algorithm and software developed
  - successfully tested for WVIOP97 (Sept. 97) data; testing data acquired during 1998
  - undergoing comparisons with GSFC lidar for Sept. 96 data
  - "best estimate" product in RLAER 8/1/98
- GSFC Raman Lidar TARFOX data analysis complete; data archived to Langley DAAC by 7/15/98
- GSFC Raman Lidar WVIOP96, 97 analyses in progress; data archived to ARM Archive by 8/15/98

Progress:

- Aerosol backscattering and extinction, water vapor mixing ratio and relative humidity profiles computed for both lidar systems for data acquired during 96 and 97 WVIOPs
- CART Raman Lidar aerosol backscattering and extinction profiles agree well with those measured using scanning ability of NASA GSFC Raman lidar (see figure 2)
- CART Raman Lidar measurements show nearly continuous record of aerosol extinction and water vapor during WVIOP97 (see figure 3)
- Aerosol optical thickness, derived from CART Raman Lidar aerosol extinction profile measurements, showed excellent agreement with those measured by Cimel sun photometer (see figure 4) and were highly correlated with precipitable water measured by CART Raman Lidar (see figure 5)

- Initial studies have shown CART Raman Lidar can measure relationship between aerosol extinction and relative humidity (see figure 6 and 7)

Collaborations

- Contacted both MODIS and MISR teams to determine how aerosol profiles measured by Raman lidars can be used to evaluate EOS data
- Have been named a MODIS Validation Affiliate
- Have had extensive collaborative efforts with DOE ARM community in
  - Evaluating water vapor measurements acquired by both Raman lidar systems
  - Combining Raman lidar water vapor profiles with AERI temperature profiles to compute relative humidity
  - Analyses of aerosols with ARM Aerosol Working Group
- Need to get more information from MISR team regarding validation activities, meetings, etc.

Data Exchange/Archival

- CART Raman Lidar data exchange to use DOE ARM Archive
- Water vapor mixing ratio and aerosol scattering ratio profile data already being archived in ARM Value-Added Product RLPROF
- Aerosol backscattering and extinction profiles to be added to ARM Value-Added Product RLAER (est. 8/1/98)
- Additional results to be posted on our EOS Validation home page (see below) and presented at MODIS, MISR Validation Meetings and ARM Science Team Meetings

Validation web page established (http://dev.www.ec.arm.gov/~turner/EOS_validation); **(est. completed 6/1/98)**

Presentations

"EOS Validation of Aerosol and Water Vapor Profiles by Raman Lidar", R. Ferrare, S.H. Melfi, G. Schwemmer, D. Whiteman, K. Evans, D. Turner, Workshop for Atmospheric Validation in EOS-AM1 and SAGE III, Hampton, Virginia, October, 1997.

"Raman Lidar Measurements of Aerosol Profiles", Rich Ferrare, Dave Turner, S. Harvey Melfi, Geary Schwemmer, Dave Whiteman, Keith Evans, ARM Instantaneous Radiative Flux Working Group Meeting, College Park, Maryland, January 1998.

"CART and GSFC Raman Lidar Measurements of Atmospheric Aerosol Backscattering and Extinction Profiles for EOS Validation and ARM Radiation Studies", R. Ferrare, D.D. Turner, S.H. Melfi, D.N. Whiteman, G. Schwemmer, K. D. Evans, J.E.M. Goldsmith, T. Tooman, ARM Science Team Meeting, Tucson, Arizona, March 1998. (**http://www.arm.gov/docs/documents/technical/conf_9803/ferrare-98.pdf**)

"Comparison of measurements by the NASA/GSFC Scanning Raman lidar and the DOE/ARM CART Raman lidar", D.N. Whiteman, G. Schwemmer, D.Turner, K. Evans, B. Demoz, S.H. Melfi, M. Cadirola, S. Wise, R. Ferrare, J. Goldsmith and T. Tooman, ARM Science Team Meeting, Tucson, Arizona, March 1998. (**http://www.arm.gov/docs/documents/technical/conf_9803/whiteman-98.pdf**)

"Upper tropospheric water vapor: A campaign of two Raman lidars, airborne hygrometers, and radiosondes", S.H. Melfi, K. Evans, D. Turner, D. Whiteman, G. Schwemmer, and R. Ferrare, ARM Science Team Meeting, Tucson, Arizona, March 1998. (**http://www.arm.gov/docs/documents/technical/conf_9803/melfi-98.pdf**)

"Quantifying Mesoscale Flows in the Troposphere", B.B. Demoz, K.D. Evans, S.H. Melfi, M. Cadirola, D. O'C. Starr, D.N. Whiteman, G. Schwemmer, D.D. Turner, ARM Science Team Meeting, Tucson, Arizona, March 1998. (**http://www.arm.gov/docs/documents/technical/conf_9803/demoz-98.pdf**)

Publications

Ferrare, R.A., S.H. Melfi, D.N. Whiteman, K.D. Evans, R. Leifer, Y.J. Kaufman, Raman Lidar Measurements of Aerosol Extinction and Backscattering - Part 1: Methods and Comparisons, accepted by *J. Geophys. Res.*, 1998.

Ferrare, R.A., S.H. Melfi, D.N. Whiteman, K.D. Evans, M. Poellot, and Y.J. Kaufman, Raman Lidar Measurements of Aerosol Extinction and Backscattering -Part 2: Derivation of Aerosol Real Refractive Index, Single Scattering Albedo, and Humidification Factor using Raman Lidar and Aircraft Size Distribution Measurements, accepted by *J. Geophys. Res.*, 1998.

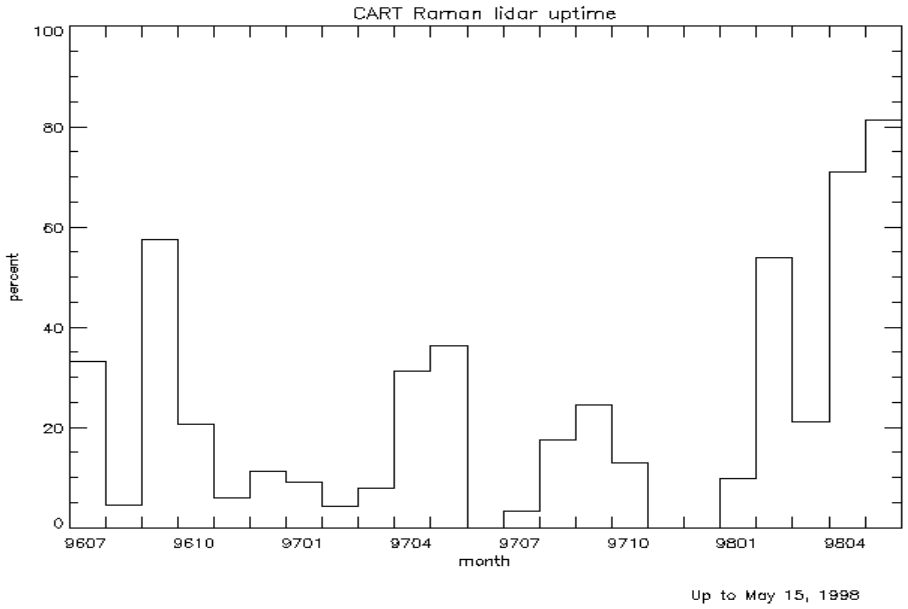

Figure 1. Percentage of run time for CART Raman Lidar during each month from July 1996 to May 1998.

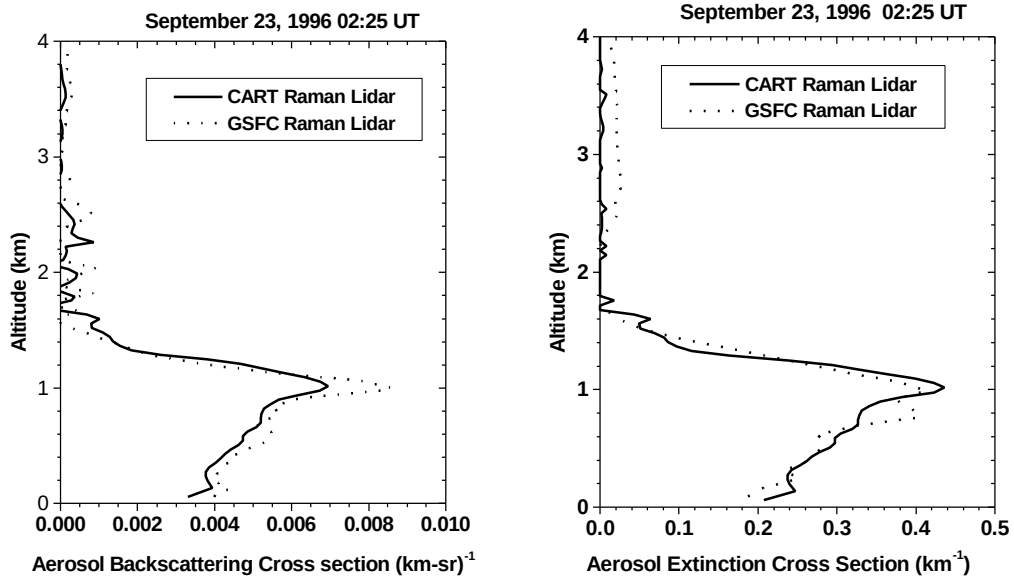

Figure 2. Aerosol backscattering (left) and extinction (right) profiles measured by CART and GSFC Raman Lidars at 02:25 UT on September 23, 1996.

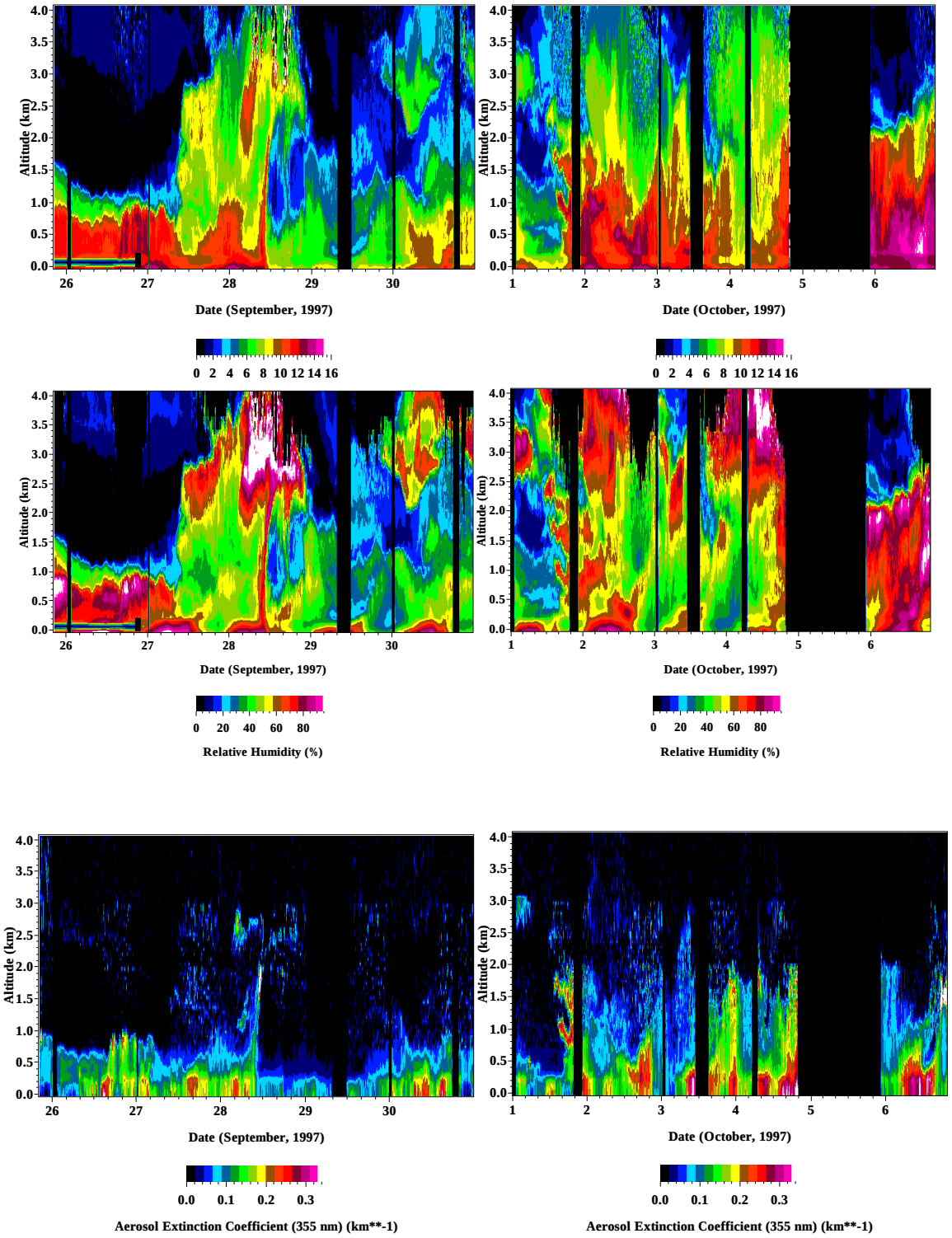

Figure 3. Water vapor mixing ratio (top), relative humidity (middle), and aerosol extinction (bottom) derived from CART Raman Lidar measurements during the 1997 Water Vapor and Aerosol IOP.

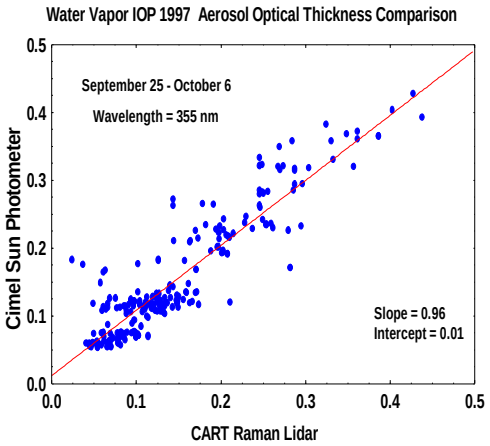

Figure 4. Correlation between CART Raman lidar and Cimel sun photometer aerosol optical thickness (355 nm) measurements during the 1997 Water Vapor IOP.

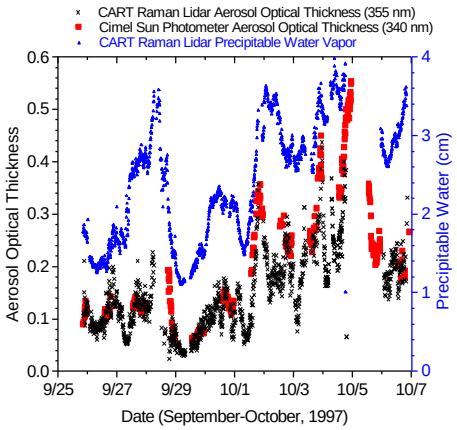

Figure 5. CART Raman Lidar and Cimel sun photometer aerosol optical thicknesses (left axis) and CART Raman Lidar precipitable water vapor (right axis) during the 1997 Water Vapor IOP.

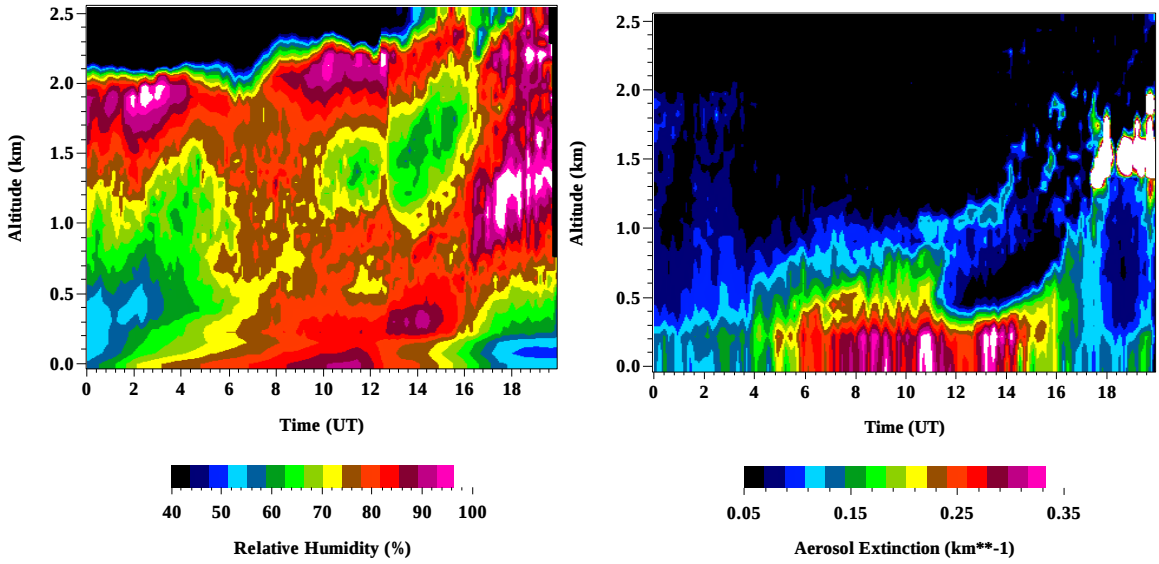

Figure 6 Relative humidity (left) and aerosol extinction (right) derived from CART Raman Lidar measurements acquired on October 6, 1997.

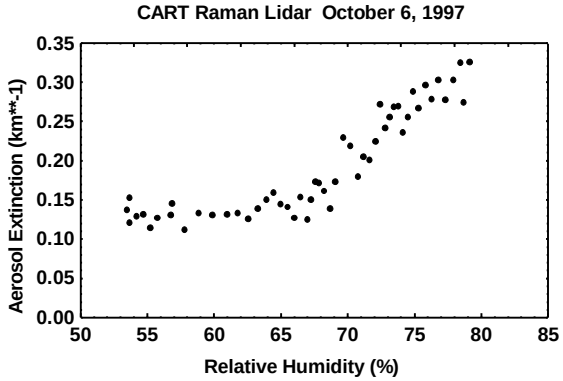

Figure 7. Aerosol extinction as a function of relative humidity derived for altitudes between 60-300 meters from CART Raman lidar measurements between 01:00-09:00 UT on October 6, 1997.